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### (54) HIGH NI ALLOY SHEET STRIP EXCELLENT IN CORROSION RESISTANCE AND ITS PRODUCTION

#### (57)Abstract:

PURPOSE: To improve the corrosion resistance of a high Ni alloy sheet strip to a greater extent by effectively using a direct sheet casting process.

CONSTITUTION: This sheet strip has a composition consisting of  $\leq 0.2\%$  C, 30-70% Ni, 10-30% Cr, one or  $\geq 2$  kinds selected from 1-20% Mo, 0.1-5.0% Ti, 0.1-5.0% Cu, 0.1-5.0% Nb, 0.1-5.0% W, and 0.1-5.0% Al, and the balance Fe with inevitable impurities. As to the texture in the sheet surface shown by the peak intensity by X-ray diffraction, the relationship in inequality  $I_{211}/(I_{211}+I_{111}+I_{110}+I_{100}) \leq 0.30$  (where I means the peak intensity of each crystal plane and each figure in the lower right hand of I represents a crystal plane) is satisfied.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention tries to aim at much more corrosion-resistant improvement in a high Ni-alloy sheet metal belt by effective use of a sheet metal direct casting process especially about a high Ni-alloy sheet metal belt which is excellent in corrosion resistance, and a manufacturing method for the same.

[0002]

[Description of the Prior Art] Although the high Ni alloy is widely used in various fields as an incinerator member by the gas turbine member, a chemical-processing-plant pipe, and these days, these days, much more corrosion-resistant improvement is desired by degradation of the operating environment. As what meets the above-mentioned request, for example by JP, 64-9392, B, it is attached to a high nickel-Cr alloy, and is especially  $\Delta_1 =$ , after the value of  $\Delta_1$  calculated by  $[\text{Cr}+1.5 \text{ Mo}+0.8 \text{ Ti}+0.5 \text{ Cu}-100 \text{ C}]$  adjusts to the presentation which becomes 25 or more -- condition-ized processing -- following formula;  $T_f \leq 60\Delta_1 - 550$  -- << -- here --  $\Delta_2 = \text{nickel} - \frac{[\text{Cr}+1.5 \text{ Mo}-20]}{12} - 35\text{C} - 27\text{N} + 14$  It has proposed carrying out at the temperature with which it is satisfied of >>, although the above-mentioned manufacturing method tries corrosion-resistant improvement with the combination of quality governing and heat treatment, it is called casting-forge-hot-rolling-heat treatment-middle rolling-heat treatment as usual about a manufacturing process -- it is complicated and many processes are needed.

[0003] By the way, development of the art of manufacturing a sheet metal belt is directly furthered from molten steel in recent years using sheet metal direct casting processes, such as the congruence rolling method and the single rolling method (for example, JP, 4-2338, B etc.). However, the steel type by which manufacture is tried in the above-mentioned sheet metal direct casting process is the stainless steel (JP, 4-24413, B, the No. Japanese Patent Publication No. 4- 24414 gazette) consisting mainly of SUS304 and SUS430 grade.

There is no example applied to the high Ni alloy.

[0004]

[Problem(s) to be Solved by the Invention] This invention relates to manufacture of the high Ni-alloy sheet metal belt using a sheet metal direct casting process which was described above, and much more corrosion-resistant improvement not only in process saving but a high Ni-alloy sheet metal belt is aimed at by harnessing the feature of this

sheet metal direct casting process. If in charge of application of a sheet metal direct casting process, it cannot be overemphasized that the manufacturing conditions of other steel types cannot be used as it is in consideration of the metal study characteristic of an application steel type even if it is necessary to specify the manufacturing conditions and is the as it is still more nearly same sheet metal direct casting process about the manufacturing conditions in a process conventionally.

[0005]

[Means for Solving the Problem]This invention Namely, less than C:0.2 wt% (% only shows below). nickel: 30-70% and Cr : Including 10 to 30%, and Mo:1-20%, Ti: 0.1 - 5.0 %, Cu:0.1 - 5.0 %, Nb:0.1 - 5.0 %, Texture of a sheet surface which one sort chosen from among W:0.1 - 5.0 %, and aluminum:0.1 - 5.0 % or two sorts or more were contained, and the remainder consisted of Fe and inevitable impurities, and was expressed with peak intensity by an X diffraction is a following formula (1).

[Equation 2]

$$I_{211} / (I_{211} + I_{111} + I_{110} + I_{100}) \leq 0.30 \quad \text{--- (1)}$$

It is a high Ni-alloy sheet metal belt which is excellent in the corrosion resistance satisfying \*\*\*\*\*.

[0006]As for this invention, below C:0.2 % contains nickel:30-70% and Cr:10-30%, And Mo : 1 to 20%, Ti:0.1 - 5.0 %, Cu:0.1 - 5.0 %, Contain one sort chosen from among Nb:0.1 - 5.0 %, W:0.1 - 5.0 %, and aluminum:0.1 - 5.0 %, or two sorts or more, and the remainder according to a sheet metal direct casting process from the molten steel which becomes the presentation of Fe and inevitable impurities. Thickness: It is in charge of manufacturing a 0.1-20-mm sheet metal belt, and is from coagulation temperature. It holds 10 s or more until it results in 800 \*\*, It continues. It is a manufacturing method of the high Ni-alloy sheet metal belt which is excellent in the corrosion resistance cooling the temperature region of 800 - 600 \*\* at not less than 50 \*\*/s in speed, cold-rolling at less than rolling reduction:10% or not less than 40%, without subsequently hot-rolling, and giving appropriate back finishing annealing.

[0007]Hereafter, this invention is explained concretely. The break-through circumstances of this invention are explained first. Now, artificers are the processes of the research on manufacture of the high Ni-alloy sheet metal belt by a sheet metal direct casting process, and the corrosion-resistant quality acquired the knowledge of there being texture of a sheet surface and strong correlation. So, in this invention, the relation between the texture of a sheet surface and corrosion resistance was investigated. The texture of a sheet surface can express a sheet surface here by peak intensity  $I_{hkl}$  of each crystal face (hkl) when X-ray diffraction is carried out, for example, it is with  $I_{100}$ . (100) It is the peak intensity of a field. To drawing 1, it is Incoloy 800. The result investigated about the relation between each crystal face and corrosion resistance is shown about an alloy. Like and the thing [ being clearer than the figure ] critical current density is high and inferior to corrosion resistance became clear (110). [ a thing ] [ a field (211) (111), a field (100), etc. / especially ]

[0008]Then, it is if it puts in another way by controlling generation of a field (211) in this invention. (211) Corrosion-resistant improvement shall be aimed at by holding down field peak intensity to below constant value. When controlling diffraction-peak-intensity  $I_{211}$  from a field (211) from this viewpoint how much to diffraction peak intensity

( $I_{211}+I_{111}+I_{110}+I_{100}$ ) from all the crystal faces, it was examined whether good corrosion resistance would be acquired. The result, 0, a ratio to total diffraction peak intensity ( $I_{211}+I_{111}+I_{110}+I_{100}$ ) of field diffraction-peak-intensity  $I_{211} - (211)$   $I_{211}/(I_{211}+I_{111}+I_{110}+I_{100})$ . When using 30 or less, it was studied that desired corrosion resistance is acquired. A sheet metal belt which becomes the texture which mentioned above cannot be manufactured at the conventional usual process. Because, it is if it hot-rolls. (211) Since a field progresses strongly, even if it performs what kind of processing after that (211) It is because it is difficult to reduce a field.

[0009]

[Function] In this invention, the reason which limited component composition to the above-mentioned range is explained below.

C: Although it adds for reservation of desired intensity, content below 0.2 % C Since it will become easy to generate carbide and corrosion-resistant degradation will be caused if it exceeds 0.2%, it is made to contain in 0.2% or less of range.

[0010]nickel: Although it was a useful component added in order that nickel may raise intensity, corrosion resistance, and creep strength 30 to 70%, less than 30% was not enough as the effect, and since the disadvantage which reaches saturation and becomes expensive rather produced the effect when it exceeded 70% on the other hand, it limited to 30 to 70% of range.

[0011]Cr: 10 to 30%, in order that Cr might raise corrosion resistance, it was an indispensable element, but when not filled to 10%, it was deficient in the corrosion-resistant improvement effect, and since the effect reached saturation when it exceeded 30% on the other hand, it limited to 10 to 30% of range.

[0012]Mo: Each of 1 to 20%, Ti: 0.1 - 5.0 %, Cu: 0.1 - 5.0 %, Nb: 0.1 - 5.0 %, W: 0.1 - 5.0 % and aluminum: 0.1 - 5.0 % Mo, Ti, Cu, Nb(s), W, and aluminum is gamma' phases.

[nickel, aluminum, Ti] Although it is a useful element which carries out dispersed precipitation of the \*\* and raises the intensity of an alloy by dispersion strengthening, it is deficient in the addition effect at less than a minimum respectively, and since degradation of processability will be caused if it adds exceeding a maximum on the other hand, these elements shall be added in the above-mentioned range, respectively.

[0013]Next, the reason which limited manufacturing conditions as mentioned above is explained. According to the sheet metal direct casting process generally, it is at the coagulation time. (100) Since the field progressed strongly, it carried out expected by this invention. (211) It is advantageous when forming texture with few fields. However, rolling process performed after that (211) The quantity of a field increases. So, in this invention method, it shall fully develop a field (100) by the preceding paragraph story of cold rolling, and it not only omits hot-rolling, but shall control growth of the field by subsequent cold rolling (211) as much as possible.

[0014]any may be sufficient as long as casting of the board belt of the grade which performs cold rolling directly from molten steel is possible about the sheet metal direct casting process first applied to this invention -- any of conventionally publicly known methods, such as the congruence rolling method, the single rolling method, and the congruence belt method, -- although -- it is applicable. It is cast piece thickness here. It may be necessary to be 0.1-20 mm. Because, coagulation speed has too quick thickness at less than 0.1 mm. (100) It is because development of a field becomes amorphous depending on the case rather than is enough, and is because big power is needed for cold

rolling and it is not practical, if it exceeds 20 mm on the other hand.

[0015]Next, from coagulation temperature It is necessary to hold between 10s at least until it results in 800 \*\*. Because, if retention time is less than 10 s, development of a field (100) will set to a post process rather than will be enough. (211) It is because there is a possibility of inducing development of a field.

[0016]From 800 \*\* It is necessary to cool at not less than 50 \*\*/s in speed about the temperature region up to 600 \*\*. Although this temperature region is a temperature region where gamma' equality deposits, it is because it can control a deposit of this precipitation phase mostly if the above-mentioned temperature region is cooled at not less than 50 \*\*/s in speed the place where not existing at the time of coagulation is preferred in order that gamma' phase may degrade subsequent cold work nature.

[0017]Subsequently, it is made above. (100) Although it cold-rolls to the sheet metal belt into which the field was fully developed, it sets to this cold rolling. (211) In order to control growth of a field, especially that rolling reduction is important. To drawing 2, it is Incoloy 800. Rolling reduction and  $I_{211}/(I_{211}+I_{111}+I_{110}+I_{100})$  the result investigated about the relation with a ratio, [ in / alloy / cold-rolled rolling ] The result investigated [ alloy / the ] about the relation between cold-rolled rolling reduction and a corrosion amount is shown in drawing 3, respectively. The results shown with the dashed line are the results of an investigation about the alloy conventionally obtained according to the process among each figure. When rolling reduction is more than 10% and less than 40% so that more clearly than drawing 2 and 3, (211) side progresses, and it is  $\{I_{211}/(I_{211}+I_{111}+I_{110}+I_{100})\} >$  as a result of being set to 0.30, corrosion-resistant degradation is caused.).

[0018]So, in this invention, it limited for the rolling reduction in cold rolling to 10% or less or not less than 40% of range. In this invention, cold rolling is not limited at once and can also cold-roll multiple times according to desired board thickness. However, the rolling reduction at the time of each cold rolling needs to satisfy above-mentioned conditions (10% or less or not less than 40%).

[0019]the temperature requirement finally used usually about finishing annealing -- namely, -- What is necessary is just to carry out in a 950-1200 \*\* temperature region. It is also possible to perform aging treatment if needed.

[0020]

[Example]10 kg of molten steel which becomes various component composition shown in Table 1 is dissolved with a high frequency induction furnace, respectively, and it is thickness by a congruence roll type sheet metal direct casting process. After considering it as a 2.0-mm cast piece, it was considered as sheet metal on the conditions shown in Table 2. Finishing annealing is the same at water cooling for 1000 \*\* and 20 minutes. About the corrosion resistance of the high Ni-alloy sheet metal obtained in this way, the investigated result is combined with Table 2 and shown. In Table 2, it writes together also about the results of an investigation of the product manufactured at the process conventionally usually consists of ingot making-press cogging-hot-rolling (4.0 mm thickness)-heat treatment (1000 \*\*)-cold rolling (3.0-mm thickness)-heat treatment (1000 \*\*) 18 t for comparison. The corrosion weight loss (mm/y) of HCl and 80 \*\*, and 15%H<sub>2</sub>SO<sub>4</sub> estimated 65 \*\* of corrosion resistance 15%.

【表 1】

(%)

鋼 種	C	Ni	Cr	Fe	他 元 素	備 考
A	0.04	31.2	20.5	残	Ti : 0.50	インコロイ 800
B	0.03	42.1	20.7	"	Ti : 1.03, Cu : 1.74	インコロイ 825
C	0.03	62.3	22.1	"	Nb : 4.4	インコネル 625
D	0.12	50.9	15.8	"	W : 4.4	ハステロイ C

[0022]

[Table 2]

No.	鋼種	凝固温度から 800℃までの 時間 (s)	800 ~ 600℃ 間の冷却速度 (℃/s)	圧下率 (%)	$I_{211} / (I_{211} + I_{111} + I_{110} + I_{100})$	65℃15% HCl (mm/y)	80℃15% H <sub>2</sub> SO <sub>4</sub> (mm/y)	備考
1	A	12	70	7	22	121	11	適合例
2	A	12	70	45	20	128	13	"
3	B	20	90	45	20	60	9	"
4	B	20	90	80	18	67	10	"
5	C	15	100	10	25	40	5	"
6	C	15	100	50	25	47	6	"
7	D	25	60	7	21	12	2	"
8	D	25	60	80	16	13	2	"
9	A	* 7	70	45	35	166	20	比較例
10	B	15	* 40	60	55	80	15	"
11	C	15	70	*20	60	66	10	"
12	D	* 5	80	*30	70	20	4	"
13	A	* 5	* 30	50	60	158	18	"
14	B	通常工程			55	80	15	"

\*は本発明の範囲外であることを示す

[0023]As for each high Ni-alloy sheet metal which might be followed by this invention,  $I_{211}/(I_{211}+I_{111}+I_{110}+I_{100})$  is so that clearly from Table 2. 0.30 It is the following,  $I_{211}/(I_{211}+I_{111}+I_{110}+I_{100})$  of the high Ni-alloy sheet metal obtained with the conventional method to good corrosion resistance having been acquired -- all -- 0.30 was exceeded and, as a result, the corrosion resistance like satisfaction \*\*\*\* was not acquired enough.

[0024]

[Effect]In this way, according to this invention, the high Ni-alloy sheet metal belt which was excellent in corrosion resistance conventionally can be obtained by the ability to combine it with process saving, and the industrial meaning is very large.

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[Translation done.]